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WIRELESS TELEGRAPHY APPARATUS.

How Made and Operated.

R. C. Browne.

I. THE SPARK COIL.

When robbed of technicalities, wireless telegraphy consists of simply creating a disturbance or vibration of the electric ether of the universe and detecting the same at some distant place by suitable instruments.

When vibrations or disturbances, commonly called waves, of electricity are caused by the passage of electricity through an insulating medium, such as air, the passage of the current must be in the form of an explosion spark, which can be produced by the instrument herein described; namely, an induction coil. For this description, a 1″ induction coil has been selected; that is, a coil capable of giving an inch spark when operated by a battery of three or four bichromate or six or eight dry cells.

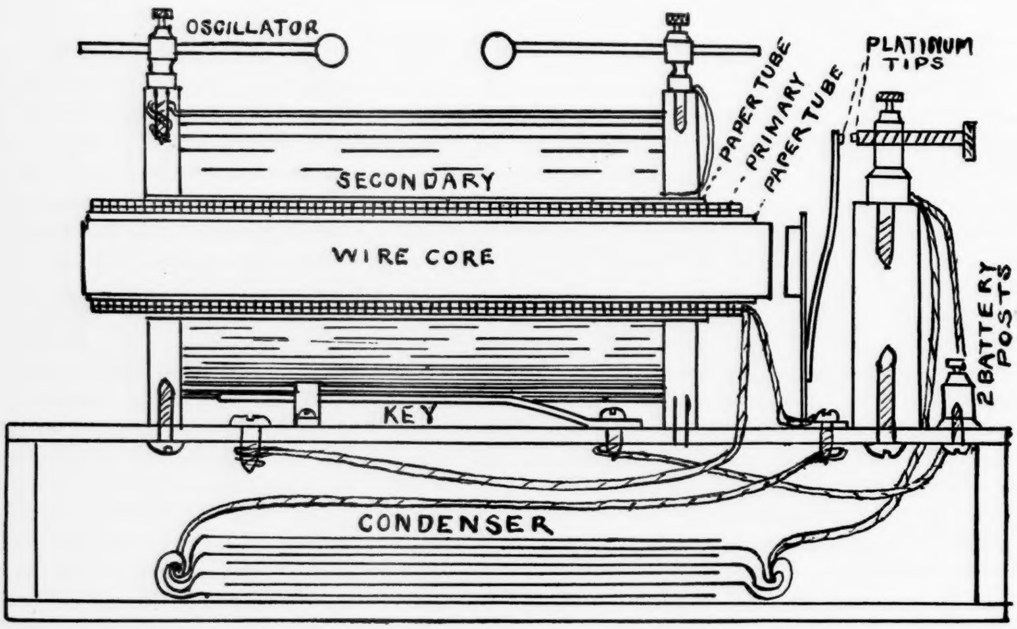
First make a pasteboard tube 10″ long and 1″ outside diameter by winding several layers of tough brown paper covered with glue or paste around a broom-handle. The broom-handle, before winding, should be freely covered with soap, so that the tube may be easily removed. When dry, give the tube a coating of shellac varnish. On this tube wind two layers of No. 14 double cotton-covered magnet wire, giving each layer a plentiful coating of shellac. A good grade of white shellac cut with alcohol will be found suitable. This winding forms the primary coil. Leave about 3″ of free wire on each end for connections.

Make another paper tube by winding several layers of the paper over the primary winding. The outside layer should be smooth and even, so that the secondary coil may be easily wound. When dry, glue firmly on to each end a piece of mahogany or other suitable wood 5½″ square and ½″ thick. Holes are bored in the center, of a diameter to make a snug fit on the outside paper tube. This makes a spool 6″ long between the ends. After this is done, commence to wind the fine wire coil, known as the secondary coil. This should be wound in the same direction as the primary coil. For this purpose 1¼ lbs. of No. 36 single cotton-covered magnet wire will be required.

Make a small hole through one of the wooden ends close to the paper tube; put one end of the fine wire through it from the inside, and commence to wind on layer after layer, coating each layer with hot paraffin and putting between each layer of wire two thicknesses of paper which has been dipped in hot, melted paraffin. Select strong white paper free from printing and holes and not very thick. For those who are not fortunate in owning a lathe the following is a simple way to wind the coil. First wind the primary by hand, then put on the ends of the coil ready for the fine wire, and push the reel or spool so made over a piece of broom-handle. Then mount it across a wooden box, so that by pushing the ends of the coil lightly with the hand it may be made to revolve quite rapidly. A heavy wooden or metal wheel driven on the end of the broom-handle spindle will act as a balance wheel and cause it to revolve more evenly. To hold the broomstick in place cut two notches, and on the edges of the box drive two nails, one each side of the broom-handle.

In winding do not wind up to the wooden ends, but leave at least $\frac{1}{2}''$ of paper beyond each layer of wire. Also do not cut holes through the paper or bring the wire up over the end next to the wooden pieces, but put the edges of the paper under the wire when a layer of wire is completed; that is, put the paper between the wire, as it comes from the coil, and the coil itself, and wind both on so that the wire will come out on the top ready for another layer. The strips of paper should be large enough for a lap of about $\frac{3}{8}''$. The success of the coil depends to a great extent upon the evenness to the top of each of the wooden ends of the coil. The holes in the binding-posts should be opposite each other. After the coil is wound it may be covered with rubber, paper or velvet to give it a neat appearance.

For the core, cut sufficient wire into pieces a trifle over 10″ long (old rusty hay wire will answer), to fill the center of the primary coil. The ends of the wire should be trued up with a file. The coil is then attached with screws to a wooden base about 14″ long, 8″ wide and 2″ high. A cigar or wooden candy box can be made over

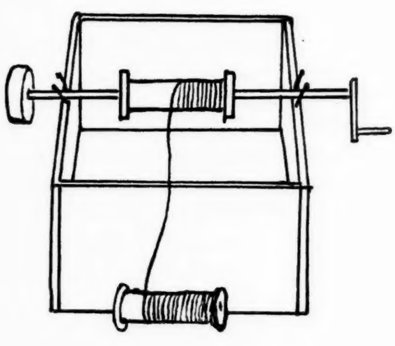


of the winding, so be careful to wind the wire as evenly as possible, never letting one turn of the wire lap over another. Also avoid all kinks; if any are found, straighten out, using care not to break the wire. Examine the wire during the winding to locate breaks, and if any are found the covering should be removed, a connection made by soldering, and the joint carefully covered with waxed thread to thoroughly insulate it.

When all the wire has been wound, connect the two ends to two binding-posts, one being screwed to the proper size. The interrupter or vibrator, which is simply an instrument very similar to an electric bell, for breaking the flow of the battery current in the primary coil, should next be made.

From a suitable piece of brass — a piece from an old alarm-clock case will answer — cut a spring $3\frac{3}{4}''$ long and $\frac{1}{2}''$ wide. Drill a hole $\frac{3}{16}''$ in diameter, $\frac{1}{4}''$ from one end, and bend that end at right angles to the spring so as to make a foot $\frac{1}{2}''$ square for fastening to the base. On the other end of the

spring solder a piece of iron weighing about ¾ oz., to form a hammer which will work against the end of the wire core in the primary coil. A piece ¼″ thick cut from the end of a ¾″ round iron rod will be about the right size. Cut out another piece of brass spring, wedge-shaped, ½″ wide at one end and ¼″ wide at the other, and 2¼″ long. Solder the wide end to the back of the spring, carrying the iron hammer about 1″ from the base, and rivet a small piece of No. 14 platinum wire or sheet platinum ¼″ from the narrow end. The best way to solder these pieces is to separately coat the parts to be joined with solder and then place them together and heat until the solder just melts. When completed, screw the foot of the hammer to the base so that the hammer will be opposite and ⅜″ from the end of the wire core.



Take a binding-post and have a thread cut through the hole for the wire so as to carry a brass thumbscrew having a small piece of No. 14 platinum wire about ⅛″ long riveted to the end of it. This screw can easily be made by threading a piece of brass wire about 2¼″ long. Bend one end to form a handle to turn it by, or solder on a brass nut.

Mount this binding-post on a block of wood and screw it to the base of the coil so that the platinum tip will press against the platinum on the spring of the hammer when the iron is away from the wire core.

We are now ready to make a key for regulating the signals. An ordinary telegraph key may be used, but a simple one can be made as follows: In a piece of brass spring 6″ long and ½″ wide drill a hole in one end, and bend it slightly, so that when screwed to the base of the coil, the other end of the spring will be raised about ¼″. Put a brass screw through the base, directly under the end of the spring, so that when pressed down, the spring will come in contact with the head of the screw, which should be fastened with a file to give a good contact. A small piece of brass spring ½″ wide, 1½″ long, should be bent and then screwed over the key spring, so that when the key is open or raised it will be held about ¼″ from the contact screw.

The condenser, which is used to intensify the power of the coil, is placed in the base and is made as follows: Cut out 60 sheets of tin-foil about 6″ wide and 10″ long, and 61 sheets of white paper 7″ wide and 9½″ long. Thoroughly soak the paper with hot paraffin wax in a shallow pan, and commence to build the layers of the condenser.

Lay a sheet of prepared paper on a board, and on top of the paper place a piece of foil, allowing one end to project over the paper 1½″ on the right side. Put on another piece of paper and then another piece of foil, this time letting the end project on the left side, and so on, being sure to alternate the projecting end of each sheet of foil.

When finished, there should be thirty ends of foil at each end of the condenser. Fold all the foil projecting on each end into a roll so as to make a good electrical contact and fasten a connecting wire to each roll of foil. This may be done by soldering the bare end of the wire to a piece of thin lead and folding this into the roll. A piece of glass or thin wood is placed on the top and bottom of the condenser and wound with tape until firmly bound together, the end being sewed.

The remaining part is known as the oscillator. This consists of two brass balls ½″ to 1″ in diameter mounted on two brass wires held in the binding-posts on the ends of the coil. The balls and wires should be smoothly joined and have no rough places. The balls should be placed about ⅛″ apart, and when signaling to any distance one ball should be connected by a wire to the earth (water pipe), and the other wire connecting with a kite or high pole, the higher the better. Two binding-posts should be placed on the base for connecting with the battery.

All the parts of the coil having been described, the connections will now be considered. For these connections, use covered No. 16 copper wire.

One battery binding-post is connected to the screw that holds the long key spring to the base, either by soldering or by twisting it under the spring. The screw that the key makes a contact with when pressed down, is connected with one end of the primary coil. The other end of the primary coil is connected to the spring of the vibrator. The post of the vibrator is connected to the other battery binding-post. The condenser should be put inside the base and one end connected to the post of the vibrator and the other end to the vibrator spring. All connecting wires should be carried inside the base, small holes being bored in the top where needed.

AN ELECTRIC WIND-VANE.

PAUL M. BENEDICT.

IF one takes any interest in meteorology it frequently happens that it would be very convenient to be able to know the direction from which the wind is blowing without going out-of-doors to look at a wind-vane. At night, and especially if the wind is light, it is rather difficult to ascertain the direction of the wind. I constructed, some time ago, for my own use, an instrument which will show at any time the "wind direction," and for want of a better name I have called it an electric wind-vane. The vane will not tell the wind direction to a degree, but it will tell it to eight points of the compass, and by the expenditure of a little more time and money, can be made to show sixteen points, but eight is, as a rule, quite close enough. The instruments used in most of the meteorological stations only show eight points.

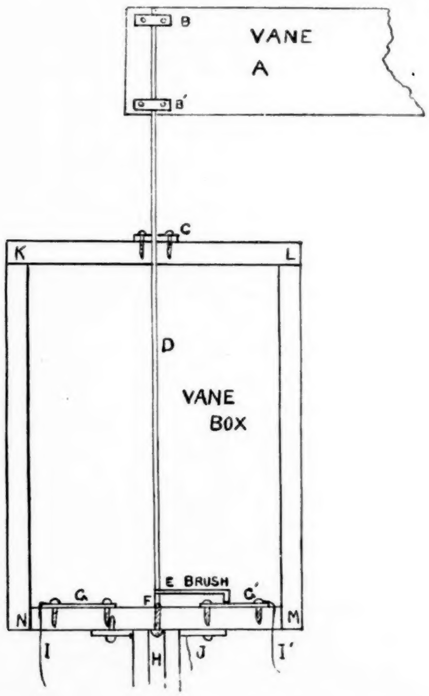
The material needed is as follows: Enough planed board $\frac{7}{8}''$ thick (white wood or pine will do) to make a box $6'' \times 6'' \times 8''$, inside measurements, a thin board $\frac{1}{4}''$ thick and $3\frac{1}{2}'' \times 12''$, or, failing this, a piece of heavy sheet iron or tin of the same size, also a piece of heavy sheet brass $5\frac{1}{2}''$ square and about $\frac{1}{16}''$ thick, a Stubbs steel rod $\frac{1}{4}''$ diameter and $14''$ long, which must be quite straight, eight round-head brass screws $\frac{3}{4}''$ long and about $\frac{1}{8}''$ diameter, about two dozen screws for making the wooden box mentioned above, a small strip of thin spring brass $2''$ long and $\frac{1}{4}''$ wide, and an ordinary paraffin candle. This completes the materials for the wind-vane part of the apparatus.

For the "indicator," which is in the house and is in electrical connection with the wind-vane, the following materials are needed: Measure the approximate distance from where you will set the vane on the roof of the house to where you will put the indicator, and get enough insulated copper bell wire, No. 16, to reach five times the distance; $250'$ will usually be ample. Also about $\frac{1}{4}$ lb. of double covered copper magnet wire, No. 18; five small binding-posts; a small magnetic compass (see that the needle swings freely); four round-head iron rivets $\frac{1}{4}''$ diameter and $1''$ long; also the metal case of an old alarm clock, six small round-head brass screws about $\frac{1}{2}''$ long, some rubber tape (piping), a small one-point switch, and two cells of any good open-circuit battery.

Take the $5\frac{1}{2}''$ square piece of sheet brass and strike a circle on it $5\frac{1}{2}''$ in diameter (Fig. 2). Mark out a diameter and another at right angles with it; drill holes at the places marked 1, 2, 3, etc. (Fig. 2), large enough for the eight round-head brass screws to pass through. Now saw the corners off with a hack-saw and file smooth until you have a nice circle $5\frac{1}{2}''$ diameter. Next cut the circle into four parts; along the diameters previously marked, cut off the surplus metal inside of the $2''$ circle and finish smooth with a file. Saw out and plane up the pieces of wood for the box, which is to measure $6'' \times 6'' \times 8''$ inside.

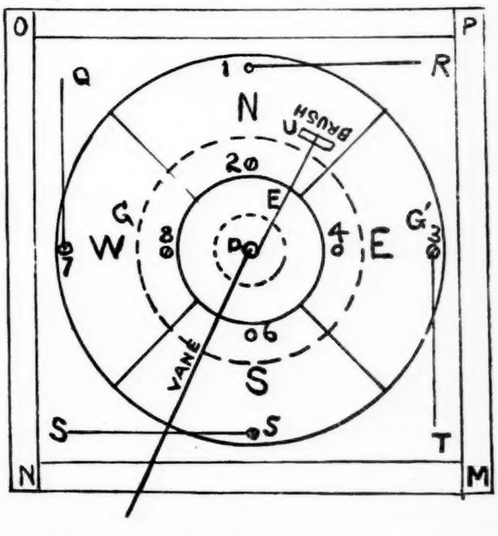
After the pieces have been planed, they must be soaked in melted paraffin for ten minutes, or lay some lumps of the paraffin on the wood and pass a hot iron over it. This is done to prevent the box from warping. A varnished or painted box will be useless in a couple of months. Take the

piece which is to form the top of the box, and drill a hole exactly in the center a little over $\frac{1}{4}''$ diameter, to allow the steel rod to slip through it easily (see Fig. 1). On the bottom piece of the box strike two circles, 2″ and $5\frac{1}{2}''$ in diameter. Drill a hole in the end of the steel rod about $\frac{1}{8}''$ deep and the same in diameter. Get a round-head brass screw 1″ long and file the point so that it will slip into the hole in the end of the rod, making an easy fit and letting the rod turn freely. This forms one



of the bearings of the steel rod (Fig. 1). Now take the square piece of brass and drill a $\frac{1}{4}''$ hole in its center, enlarging with a round file if necessary, so that the steel rod will turn easily in it. This forms the other bearing (Fig. 1). Screw to the top of the box, so that the hole in the brass will coincide with the hole in the wood. Then screw the four brass sections, N. E. S. W. (Fig. 2), on the bottom of the box, so as to fit the $5\frac{1}{2}''$ and 2″ circles previously marked, taking care that the pieces do not touch each other at any point. Leave the outside screws loose. Drill four small holes through bottom piece of box, near the outside screws in the brass pieces, to receive the connecting wire. Run a piece of the bell wire about 1′ long up through each of these holes, turning a bare end under the head of each outside screw. Connect another piece of wire to the brass screw (Fig. 1) and see that it does not touch any of the brass sectors or screws in them.

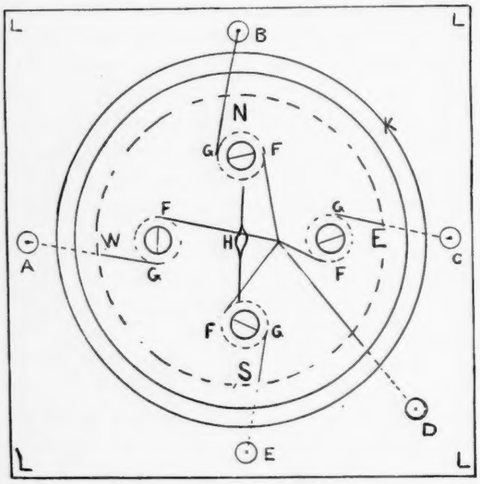
Now take the piece of thin spring brass and solder it at right angles to the steel rod (E, Fig. 1), about 1″ from the end which has the small hole drilled in it. To do this, make the rod rough with a file and then rub a piece of brass over the rough piece. The rod will take a thin coating of brass, and by using strong chloride of zinc as a wash, or a soldering paste, it is easy to solder the brass to the steel. Bend the brass spring again at right angles about $\frac{1}{2}''$ from the free end with a slight upward curve at the outer end, so as to form a "brush" or "shoe" (U, Fig. 2), which, when the steel rod is in place, will slide around on the brass sectors, as the rod turns in either direction, without hitting the screws in the sectors and without



catching in the slots between them. Slip the top piece of the box, with the square piece of brass screwed to it, on to the steel rod and proceed to put the box together, leaving out one side. If the box cannot be set on something flat on the roof of the house, a firm, level support should be made for it. Attach the vane (the piece of thin wood or sheet iron) to the steel rod by small cleats (B and B′, Fig. 1), and the vane is completed.

For the indicator obtain the metal case of an old alarm clock and make a baseboard $\frac{1}{4}''$ thick to fit the bottom of it. The side of the clock may be cut down with a hack-saw so that it will not be over $1\frac{1}{4}''$ high. Screw it to the baseboard with small round-head brass screws. Make a second baseboard $5\frac{1}{2}''$ square and mark a circle in the center of the diameter of the clock case.

Take the four rivets and anneal them, which may be done by putting them in the kitchen fire and leaving them to cool slowly as the fire goes out at night. When annealed, wind the shank with one



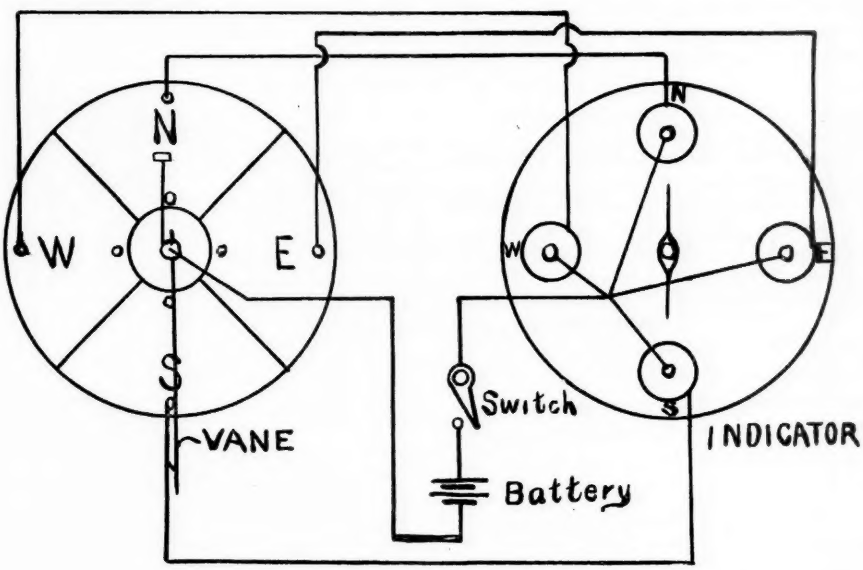
thickness of rubber tape or four thicknesses of waxed paper, and then wind on four layers of the No. 18 cotton-covered magnet wire, beginning at the head, leaving 6″ of free wire on each end for connections. Tie down the outside ends with twine. We now have four small electro-magnets. Mark a circle on the upper baseboard 2″ in diameter. Mark out a diameter and one at right angles, and where they meet the circle bore four holes through both baseboards just large enough to receive the magnets, which should be pushed into the holes with the heads on the upper side. If necessary, wrap a little paper around them to make them fit tightly. The ends for connections should be on the underside. Put the five binding-posts on the outside baseboard, one in each corner and one in the center of one side, and run the outside end of the wire on each magnet to a post. Connect all inside ends together and run a wire from them to the fifth binding-post. Take the glass top off the little compass and then stick a sharp needle point up in the center of the baseboard, so that when the compass needle is placed on it, the top of the pivot will be about $\frac{3}{8}''$ from the baseboard.

The needle must stand straight and the compass needle swing freely on it. Get some good white cardboard and cut out a circle which will just fit inside the case. Mark two circles near the edge in ink, one about $\frac{1}{2}''$ inside the other, and then divide the circles into four equal parts and mark each line N. E. S. W. like a compass. Push the disc of cardboard down over the needle and turn it until the mark N. is opposite one of the magnets, then push it down so as to rest on them.

To connect the two parts, cut five pieces of the bell wire the necessary length, and mark four of the wires at each end with tags on each for N. E. S. W. Different colors of bell wire may be used if obtainable and the tagging avoided. Twist the five ends together and fasten to a nail or any convenient support, and at every two feet or so wind a few turns of rubber tape or twine around them. In this way a very good cable may be made. Set up the indicator in the house on a level support. Set up the vane-box on the roof of the house; it should be above anything on the roof. If necessary, put it on a pole and secure it by guy wires. The box must be level and the rod perpendicular or the vane will not swing true in a light wind. Turn the box on its support so that two of the brass sectors are in the N. and S. lines, and the narrower spaces between them lie N.–E., S.–E., etc. Turn the steel rod so that the little brush is on the center of the sector on the north, and then turn the wooden or sheet-iron vane on the rod so that it will be just opposite the brush, and clamp it there, so that when the wind causes the vane to point north, the brush will point N. and make contact with the N. sector (Fig. 2).

Connect one end of wire marked N. to the sector N. and the other end to the binding-post which is in connection with the magnet opposite N. on the cardboard dial. Connect the other wires and sectors in the same way. Connect the fifth wire in the cable to the screw forming the lower bearing of the steel rod, and somewhere near the other end connect it to one pole of the battery of two dry cells. Lead a wire from the other pole of the

battery to the switch and one from the point of switch to the fifth binding-post on the indicator which is in connection with all the inside wires of the electro-magnets. If everything is rightly made and connected, on closing the switch the compass needle will swing around and point on the dial to the direction from which the wind is blowing. If the needle keeps jumping from N. to E. or E. to N., the wind direction is N. E., etc. If the wrong end of the needle points to the magnets, reverse the connections at the battery. Now go outdoors



and note the direction of the wind, and if you find the indicator shows it correctly, well and good; if not, go over the connections again and the way the vane is set in relation to the brass brush or shoe. When everything is correct, screw on the side of the box which was left out, and close all cracks with shellac.

The pivot of the compass needle must not touch the glass. Oil the bearings of the steel rod in the vane-box occasionally. The only part of the instrument which will wear to any extent is the little brass brush or shoe, but even this will last a year or so. By making eight brass sectors and eight electro-magnets and having nine wires, the vane can be made to show the wind direction to sixteen points of the compass.

SCIENCE BREVITIES.

INFECTED RATS AND PLAGUES.— The discovery that the plague is disseminated by rats will necessitate a new international congress to discuss the matter of infectious diseases, declares a contributor from the Institute of Infectious Diseases in Berlin. The rulings of the conference of 1897 are now obsolete. Rats are to the spread of the plague, the writer declares, what water is to cholera. The principal preventive measure is to destroy all the rats on a ship leaving an infected port. A single infected rat escaping to shore is infinitely more dangerous to the community than plague patients, as contagion from the latter can almost certainly be controlled. Ships can be cleared of rats by means of poisonous gases, without injury to the cargo. The ship "Pergamon" recently arrived at Hamburg from an infected port with dead rats, but no cases of plague on board. Prompt extermination of the rats before unloading prevented any infection of the crew or workmen unloading the ship.

THE highest lighthouse in the world has been installed at Vierge Isle, on the Road de Brest. The light is 330 feet above the sea, and is visible for a distance of 39 miles.

HOW TO MAKE A POWERFUL BICHROMATE BATTERY.

J. Pike, in the *Model Engineer*.

Although bichromate cells are easily made and put together, as a rule — however suitable they may be for lighting purposes — if there is heavy work to be done, as in driving a small motor, or running a model electric car, they quickly fall off in power. The following method of construction may be followed with considerable advantage: Briefly, the elements are made up of two zincs and three carbons for each cell, and I propose to describe two such cells, made to fit the well-known "Hartley" jam jars. These jars vary a little in capacity, and it will be well, therefore, to select them (referring to the 2-lb. size) of widest internal diameter.

Procure from electrical stores six carbon plates, $5\frac{1}{4}''$ by $2\frac{3}{4}''$; this appears to be a stock size. I have tried to get larger plates, but without success. They should have two holes drilled in one end. Get from a dealer in iron and metal four pieces of stout zinc, $\frac{1}{8}''$ thick, and of size similar to the carbon plates — I find it easier and probably much cheaper to get these cut to order; they require to be drilled at one end, a hole $\frac{1}{8}''$ in each, centrally, and about $\frac{1}{4}''$ from the end; and they must then be amalgamated.

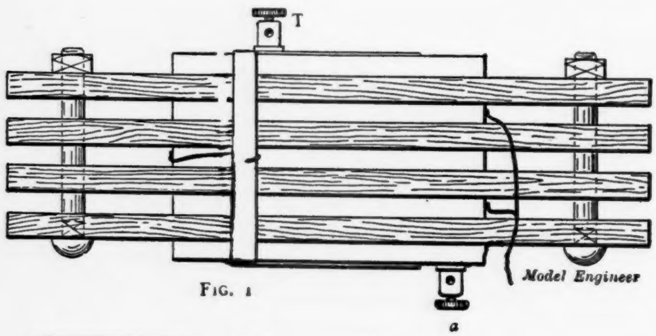


Fig. 1

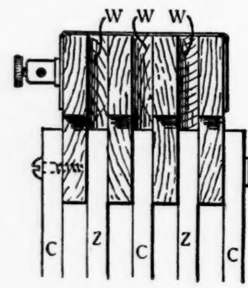


Fig. 2.

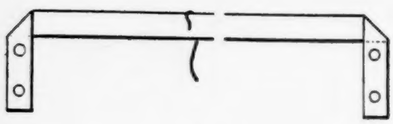


Fig. 3.

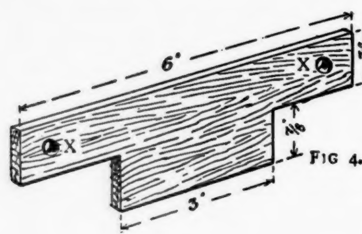


Fig 4.

To amalgamate the zinc plates effectively, provide an ounce or two each of strong sulphuric acid and quicksilver; put a little water into an old soup plate, add sulphuric acid to make a strong acid solution (say about one part to two or three of water), and by the aid of an old toothbrush rub the zincs all over with this acid solution. Now pour the mercury into the dish, bring one edge of the zinc plate up to it, and with the brush sweep a little of the mercury on to the zinc plate. If the acid has been strong enough to really clean the surface of the zinc, the mercury will attach itself rapidly, and may be brushed all over, the amalgamation being completed very easily and effectively. Rinse the zincs in water, and set up to drain; pour off the acid from the mercury (if any remains), wash this in water, and bottle for future use.

In order to insure that as large a surface as possible of zinc and carbon is available to the action of the bichromate solution, I provide pieces of wood (holders, in fact) of the shape in Fig. 4. Eight pieces are required of strong wood, that is to say, wood not easily split, and it should be at least $\frac{5}{16}''$ thick, but need not be more. Having cut the eight pieces, clamp four of them together, and carefully bore a hole at each end, as shown in Fig. 4 at X. This may be done with a brace and

small bit, or by the primitive method of a red-hot iron rod. The hole should be just large enough to take a $2\frac{1}{2}''$ small iron bolt, the thickness of which is rather under $\frac{1}{4}''$. An attachment of wire to the top of each zinc must now be made, and to do this, clean about an inch of the top edge with a file, and solder thereto one end of a 6″ length of No. 16 copper wire; bring the wire out straight, as it is to be bent up afterwards. Provide next four terminals, those with a sharp-pointed screw; and also two strips of thin brass cut and bent over as in Fig. 3, the holes in the ends being drilled to coincide with the holes in the outside carbon plates.

We may now proceed to build up the battery. By means of short wood screws attach a zinc plate to the tongue of one of the wood holders; cut a piece of thin wood the thickness of the zinc, and 3″ long by $\frac{1}{2}''$, and attach it with a drop of seccotine just above the zinc, bringing it up flush with the top. Now place another holder (adjust a carbon plate this time) and insert underneath the screws before making tight the end of a 6″ length of wire. The end should be turned roughly around each screw, and the other end brought out in the opposite direction to the zinc wire. Fill up the space above the carbon with another piece of thin wood; adjust another holder and screw on a zinc plate; see that the attached wire comes out similarly to that on the other zinc, and fill up the space above as before. Now another holder, and we may insert the bolt at each end and screw up. The small wood insertions at the top of each central zinc and carbon are, of course, to take up the pressure when the bolts are screwed tight —a reference to the Figs. 1 and 2 should make this quite plain. The two outside carbon plates are screwed on from the outside, the thin strip of brass being adjusted and bent over to make the connection. One of the terminals should be used in place of a brass round-head screw (see T in Fig. 1); the screw inserted into the zincs is central, and never near the screws used in the carbons, and of course must not be long enough to go right through the wood. The wire from the central carbon is brought up, turned around the brass strip, and soldered; and the two wires from the zincs also brought up, coiled around each other, soldered, and connected to a terminal, which may be screwed in on the opposite side to the carbon terminal,—a sectional view is shown in Fig. 2,—and looking down, the top of battery has the appearance of Fig. 1. Finally, soak the whole of the woodwork in shellac varnish,—perhaps hot paraffin wax would be better,—and when thoroughly dry and the battery dropped into chromic acid solution, they work admirably.

THE measure introduced in Parliament a couple of seasons ago by T. M. Healy to make possible the utilization of the vast and wasted water power of Ireland will be brought up again at this session. The measure, though a most admirable one in every respect, was for some reason opposed by the landlord interest, and it accordingly received its quietus in the House of Lords. Interest in it is revived by a plan now being discussed in France for the exploitation of the resources of the Pyrenees. The mineral wealth of these mountains, particularly in zinc, aluminum and iron, has been esteemed highly since 1874. The problem has been to work them at a profit, owing to the difficulties of transport, on the one hand, and the absence, on the other, of coal to smelt the ores on the spot. The idea now is to use for this latter purpose the water power of the mountain torrents. It is claimed that in the adoption of a plan of this sort lies the industrial regeneration of France and Ireland. It is computed that the wasted water power of the Pyrenees is equal to the whole of the steam power employed in all the factories of Europe. In Ireland the conditions are similar. That large tracts of territory in Ireland contain mineral wealth of various kinds is undeniable, and if some such measure as the Healy bill became law, a long stride would have been taken toward the industrial regeneration of the country.

"WHILE M. Santos-Dumont was inflating the balloon of his No. 6 airship at Monaco," says *The Scientific American* (April 5), "he was commanded by the authorities to cease immediately the process of hydrogen-making, on account of the extraordinary effect that the drainage of refuse acids and chemicals into the bay was having on the water, which had turned a brilliant orange, and which it was feared might have an injurious effect on residents near the sea-front, besides poisoning the fish.

STUDIES IN ELECTRICITY.

VIII. RESISTANCE IN CIRCUITS.

In the last chapter the resistance offered by conductors to the passage of the electric current was considered. If we examine different points of a circuit by means of suitable instruments, we will discover that there is a gradual fall in the potential, proportionate to the distance from the source, where the potential is highest. This fall in potential is directly due to the resistance of the conductor. In an electric-light system, the lighting circuits are maintained at a substantially uniform potential by means of feed wires, which convey additional current to suitable points in the circuits, to restore the loss in potential due to the resistance of the circuit.

The fall in potential of a large current is usually measured with a voltmeter. With smaller currents, an instrument known as a wheatstone bridge is often used. A description of the construction of such an instrument will be given in the next number of this magazine, together with the method of using it.

The loss of potential due to resistance represents the amount of energy converted into heat. In addition to the resistance of a conductor may be that of a counter E. M. F., such as is developed by the rotation of the armature of a motor. This opposing current reduces the available E. M. F., acting as so much additional resistance to the flow of the current, and is also converted into heat. Joule found the heat developed in a circuit to be proportional to the resistance, to the square of the strength of the current, and to the time the current flows.

Many important uses are made of this property of developing heat by resistance. In blasting, a charge is ignited by heating a wire of high resistance, which is in contact with a fuse. Torpedoes may be exploded beneath the water, at any desired distance from the operator. In electric welding, a large current of low voltage is passed through the two pieces of metal to be welded. At the points of contact the resistance is very high, the current having but a very imperfect path. The heat developed at the point of contact soon brings the adjoining ends of the metal to a high heat, the increase in temperature increasing the resistance. Cooking by electricity is but another use of heat developed by the resistance of conductors arranged for that purpose.

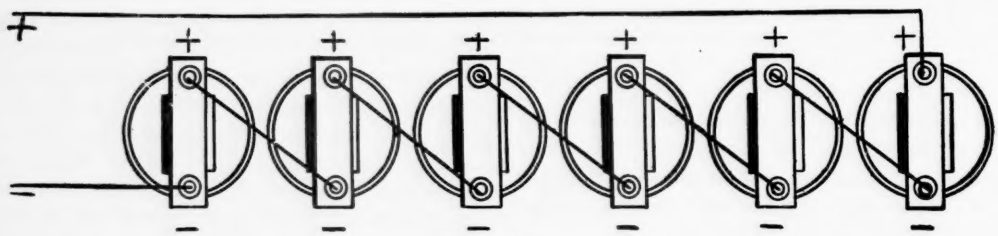


Fig. 22.

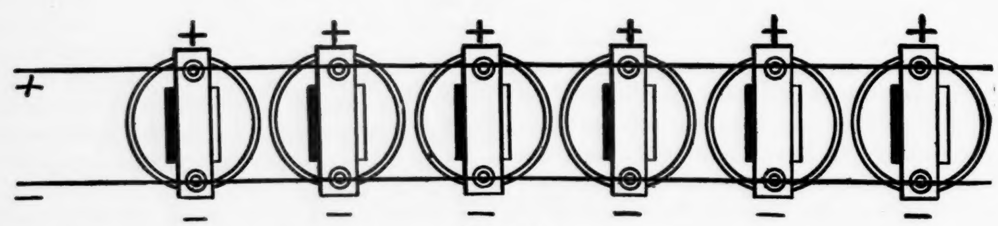


Fig. 23.

In addition to a simple circuit, with but one path for the flow of the current, are those known as divided circuits, in which the current is divided between two or more paths. If an additional path serves simply as a by-pass for only a small portion of the whole current, it is termed a *shunt.* This is a device much used in motor construction and will be considered later. The resistance of each path of a divided circuit determines the current flowing through it, the relative strength of current in two branches being proportional to their separate conductances, or inversely proportional to their resistances. The joint resistance of a divided circuit will be less than that of either path alone, as the current has two paths through which to travel, in place of one. If the resistances of two paths are equal, then one-half of the whole current will pass through each path. If one path has twice the resistance of the other, then only one-half as much current will pass through the path of greater resistance as will pass through the path with the lesser, or one-third of the total current.

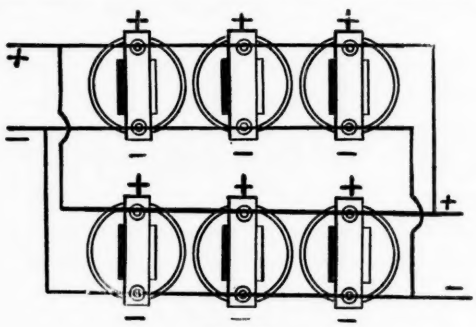


FIG. 24.

The joint resistance of a divided circuit is determined by dividing the product of the two separate resistances by their sum. This is known as the law of shunts, and should be studied until fully understood. To illustrate, suppose one branch of a divided circuit to have a resistance of 3 ohms, and the other a resistance of 6 ohms. The product of the two is 18, their sum 9; dividing, we find the joint resistance to be 2 ohms, or less than that of either branch singly. When the division is into more than two branches, the formula is a little more complicated, but a little study will make it plain. The joint resistance of any number of branches of a divided circuit is the reciprocal of the sum of the reciprocals of the separate resistances. The reciprocal of any number is the quotient obtained by dividing 1 by that number. To illustrate, assume a divided circuit of three branches of 10, 20 and 25 ohms resistance respectively, the problem would be as follows:

The reciprocal of 10 is	.10
The reciprocal of 20 is	.05
The reciprocal of 25 is	.04
Sum of the reciprocals	.19

Dividing 1 by .19 gives 5.26 ohms, the joint resistance.

With battery circuits, the grouping of the cells differs with different uses. If a current of high E. M. F. or voltage is desired, the cells are arranged in series, as shown in Fig. 22. In this arrangement the current of each cell passes through those following, the positive terminal of one cell being connected to the negative of another. But while this arrangement increases the E. M. F., it also increases the internal resistance, as the current has to travel through the resistance of each cell following. So for that reason this arrangement is subject to limitations which have to be considered in ascertaining the most desirable way of grouping a battery. The usual method is to have the internal resistance of the cells equal the external resistance of the circuit. If the external resistance be small, however, the parallel grouping is employed. In this arrangement (Fig. 23) the positive poles are all connected with each other and the negative poles together. The internal resistance is thus much reduced, the current having several paths in place of one. The E. M. F. of this arrangement is but that of one cell.

It is sometimes necessary to make a combination of the two forms of grouping; one which will be partly in series and partly in parallel, as shown in Fig. 24, which represents two groups of cells in parallel with three cells in series in each group. In general, it may be said that the best grouping to secure *economy* is that in which the internal resistance is small compared with the external; to secure the *greatest current*, when the internal resistance equals the external; to secure the *quickest action*, when the internal resistance is higher than the external.

"IN spite of its enormous size," says *The Scientific American*, "the Cathedral of Nôtre Dame in Paris has hitherto been lighted by wax candles, as gas, it was thought, would damage the walls and valuable paintings. Now it is to be electrically lit.

AMATEUR WORK

63 KILBY ST., BOSTON

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JUNE, 1902

Contents

USEFUL RECREATION.

How much thought do you give to the use of leisure time,— to the minutes and hours given to recreation and sport? Have you ever considered that this time, or a portion of it, could be made more useful and permanently profitable than you, perhaps, are now making it? The old adage, "All work and no play makes Jack a dull boy," is quite true; but, on the other hand, do we not too often give to pastime a greater portion of time than is advisable? Would it not be better if we changed the character of our recreation to something more instructive, and yet quite as enjoyable, as continued play and sport?

Many of our readers will soon begin the "long vacation," when school cares and studies will be laid aside and almost forgotten. Undoubtedly many have already formed plans for some of the time, but others have not. To this latter class the importance of so doing is brought to their attention, if they desire to find themselves as all progressive boys should, better in mind and body when school work is again resumed. Some plan for developing useful recreation lies within the possibilities of everyone. Heedless is he who lets pass the opportunity for improving it.

It might be thought that a glacier would be the last place to search for microbes. According to a note presented to the Paris Academy of Sciences by Janssen, the celebrated French astronomer, however, M. Binot, chief of the Pasteur Institute laboratory, has lately been studying the Mont Blanc glaciers from the bacteriological standpoint by taking borings at different points, so as to bring up specimens of ice from various depths. An examination shows that in all layers of the glacial ice colonies of microbes of different species are present.

Prof. Charles Wilson has announced to the Royal Society a new determination of the temperature of the sun, which, with due allowance for slight unavoidable errors, is placed at 6,200 degrees Centigrade (11,192 Fahrenheit). If the probable absorption of the sun's radiated heat by its own atmosphere is allowed for, the mean temperature of the sun's body is placed at 6,600 degrees Centigrade. Professor Wilson started his calculations almost ten years ago.

MECHANICAL DRAWING.

EARNEST T. CHILDS.

VIII. DRAUGHTSMEN'S SCALES.

IN the first talk on Mechanical Drawing under the heading of "Instruments, Their Use and Care," a brief description was given of one class of scale, commonly known as the Architect's scale. As therein stated, the common scales have subdivisions which are divided to a scale of $\frac{1}{8}''$ to $1'$ up to $3''$ to $1'$. This class of scale is used most commonly on architectural and machine drawing. There is another style of scale used by civil engineers which is entirely different from the architect's scale, which is generally called the Engineer's scale. The scale is divided into inches, and each inch is divided into a certain number of parts, from 10 to 100. That is, in a triangular scale having six edges, the common subdivisions will be 10, 20, 30, 40, 50 and 100 to the inch. To make the outfit complete another scale is necessary, giving 60, 70 and 80 divisions to the inch, and perhaps repeating some of those on the first scale. Some draughtsmen prefer to have a collection of flat scales instead of a triangular scale. If expense is not to be considered this is a good idea, as it lessens the liability to error, as the draughtsman uses only the scale needed for the drawing on which he is working.

While the use of scales is familiar to all draughtsmen and to all mechanics who are accustomed to read drawings, there are many who have only the faintest idea of the use of scales as applied to drawing work, or as applied to everyday work of any sort. The primary function of the draughtsman's scale is to produce on a small area a representation having the exact proportion of a much larger object or area.

For instance, suppose that a man has a tract of land, and wishes to build on it a house of a certain size. He also wishes to know the most satisfactory arrangement or location for the house on the land. Also suppose the lot to be irregular, and not quite level. He may be able to take a tape and measure off the ground, locating the corners of his house by stakes; but when this is done he cannot take a comprehensive view of the situation and be sure that he has the best location. For illustration, assume the lot to be $100'$ deep, $60'$ wide at the front and $50'$ wide at the back; and the house to be $25'$ by $40'$. A man standing in front and looking at four stakes cannot accurately judge the situation. By drawing a plan of the land, on a scale of $8'$ or $10'$ to $1''$, he can draw in his house plan to the same scale, and readily determine just how much room he has to spare, and just where he wants the house located, to best utilize the spare land.

The same principle applies to larger work. A large group of buildings may be laid out on a $24''$ by $36''$ drawing board so that the eye can grasp the association of the various buildings, even though they cover several acres. Should the attempt be made to study out the arrangement by staking off the ground, nothing but confusion could result. A drawing of this type may be made to a very small scale, perhaps $50'$ to the inch; but since it enables the eye to grasp the entire situation, it is better and more comprehensive than if it were drawn four times the size.

This illustrates the use of the scale on preliminary work where it is necessary to determine the most desirable location. After this preliminary work has been settled, it becomes necessary to prepare details for the construction. Here, for the sake of accuracy, it is necessary to use a relatively larger scale. Building plans are usually drawn on a scale of $\frac{1}{4}''$ to $1'$; that is, $1'$ on the drawing equals $48'$ in the building. A building $50'$ by $100'$ may be shown on a plan $15''$ by $30''$, and the arrangements of partitions, doors, windows and equipment may be predetermined, thus preventing mistakes and conflictions. Small details of construction are often worked out on quarter-size, half-size, or even full-size detail sheets, for the sake of greater accuracy.

This illustrates the relation between the draughtsman's scale and the building trade, the scale being a very important factor in the design and erection of the building. Too little attention is given to the importance of the scale, and few who use them continually, realize their importance.

The scale, like the pencil and triangle, is part of the draughtsman's equipment, and that is all the thought given to it.

On machine drawing the scale is equally invaluable. While a large amount of work has to be laid out to full scale, by far the larger part is drawn to scale varying from $\frac{1}{2}''$ to $1'$ up to $3''$ to $1'$, the latter being quarter size. By means of the scale the relative proportions of the machine may be shown, and the eye can detect at a glance any inaccuracies which might be overlooked until the machine was about complete, or if the scale drawing had not first been made. It is necessary to learn how to use a scale accurately, as a scale drawing should be correct in every detail, even though figures are given for all important dimensions.

Thus it is evident that the scale is one of the draughtsman's most important instruments, as by its use he is enabled to see comprehensively what otherwise would be absolutely impossible.

Wireless Telegraphy for Scotch Lighthouses. — It has been decided to adopt the Marconi system of wireless telegraphy in connection with the lighthouses round the north and west coast of Scotland. The commissioners of the northern lighthouses of Scotland have the matter in hand. They propose to carry out the first installation at the Flannan Islands, which are about sixteen miles off the west coast of Lewis. This is practically the first land sighted by vessels coming from America, and a wireless telegraphy station at such a point will doubtless prove of great value.

PROPORTIONS FOR U. S. STANDARD V. THREADS.

U. S. STANDARD THREAD.				STRENGTH.	THREAD FOR ROUGH IRON SIZES.			
Diameter Screw.	Threads per inch.	Diameter at Root of Thread.	Diameter of Tap Drill.	Tensile Strength at 5,000 lbs. per square inch.	Diameter Screw.	Threads per inch.	Diameter at Root of Thread.	Diameter of Tap Drill.
1/4	20	.185	3/16	134 lbs.	1/4 + 1/64	20	.179	7/32
5/16	18	.240	1/4	226 "	5/16 + 1/64	18	.232	17/64
3/8	16	.294	5/16	339 "	3/8 + 1/64	16	.282	5/16
7/16	14	.344	23/64	465 "	7/16 + 1/64	14	.329	3/8
1/2	13	.400	13/32	625 "	1/2 + 1/64	13	.382	7/16
9/16	12	.454	15/32	809 "	9/16 + 1/64	12	.434	1/2
5/8	11	.507	17/32	1,009 "	5/8 + 1/64	11	.483	17/32
11/16	11	.569	37/64	1,271 "	11/16 + 1/32	11	.561	39/64
3/4	10	.620	5/8	1,500 "	3/4 + 1/32	10	.608	21/32
13/16	10	.674	11/16	1,780 "	13/16 + 1/32	10	.671	23/32
7/8	9	.731	3/4	2,100 "	7/8 + 1/32	9	.714	25/32
15/16	9	.793	13/16	2,470 "	15/16 + 1/32	9	.776	27/32
1	8	.837	27/32	2,750 "	1 + 1/32	8	.815	7/8
1 1/8	7	.940	31/32	3 460 "	1 1/8 + 1/32	7	.909	31/32
1 1/4	7	1.065	1 3/32	3,900 "	1 1/4 + 1/32	7	1.034	1 3/32
1 3/8	6	1.160	1 3/16	5,300 "	1 3/8 + 1/32	6	1.117	1 3/16
1 1/2	6	1.284	1 9/32	6,400 "	1 1/2 + 1/32	6	1.243	1 5/16
1 5/8	5 1/2	1.389	1 13/32	7,650 "	1 5/8 + 1/32	5 1/2	1.341	1 13/32
1 3/4	5	1.491	1 1/2	8,800 "	1 3/4 + 1/32	5	1.435	1 1/2
1 7/8	5	1.616	1 5/8	10,150 "	1 7/8 + 1/32	5	1.560	1 5/8
2	4 1/2	1.712	1 3/4	11,500 "	2 + 1/32	4 1/2	1.646	1 21/32

DECIMAL EQUIVALENTS.

$\frac{1}{64}$ .015625	$\frac{17}{64}$ .265625	$\frac{33}{64}$ .515625	$\frac{49}{64}$ .765625
$\frac{1}{32}$ .03125	$\frac{9}{32}$ .28125	$\frac{17}{32}$ .53125	$\frac{25}{32}$ .78125
$\frac{3}{64}$ .046875	$\frac{19}{64}$ .296875	$\frac{35}{64}$ .546875	$\frac{51}{64}$ .796875
$\frac{1}{16}$ .0625	$\frac{5}{16}$ .3125	$\frac{9}{16}$ .5625	$\frac{13}{16}$ .8125
$\frac{5}{64}$ .078125	$\frac{21}{64}$ .328125	$\frac{37}{64}$ .578125	$\frac{53}{64}$ .828125
$\frac{3}{32}$ .09375	$\frac{11}{32}$ .34375	$\frac{19}{32}$ .59375	$\frac{27}{32}$ .84375
$\frac{7}{64}$ .109375	$\frac{23}{64}$ .359375	$\frac{39}{64}$ .609375	$\frac{55}{64}$ .859375
$\frac{1}{8}$ .125	$\frac{3}{8}$ .375	$\frac{5}{8}$ .625	$\frac{7}{8}$ .875
$\frac{9}{64}$ .140625	$\frac{25}{64}$ .390625	$\frac{41}{64}$ .640625	$\frac{57}{64}$ .890625
$\frac{5}{32}$ .15625	$\frac{13}{32}$ .40625	$\frac{21}{32}$ .65625	$\frac{29}{32}$ .90625
$\frac{11}{64}$ .171875	$\frac{27}{64}$ .421875	$\frac{43}{64}$ .671875	$\frac{59}{64}$ .921875
$\frac{3}{16}$ .1875	$\frac{7}{16}$ .4375	$\frac{11}{16}$ .6875	$\frac{15}{16}$ .9375
$\frac{13}{64}$ .203125	$\frac{29}{64}$ .453125	$\frac{45}{64}$ .703125	$\frac{61}{64}$ .953125
$\frac{7}{32}$ .21875	$\frac{15}{32}$ .46875	$\frac{23}{32}$ .71875	$\frac{31}{32}$ .96875
$\frac{15}{64}$ .234375	$\frac{31}{64}$ .484375	$\frac{47}{64}$ .734375	$\frac{63}{64}$ .984375
$\frac{1}{4}$ .25	$\frac{1}{2}$ .5	$\frac{3}{4}$ .75	1 1.

Proportions for Nuts.

Diameter Bolt.	Short diameter Hexagonal Nut.	Long diameter Hexagonal Nut.	Thickness Nut.
$\frac{1}{4}$	$\frac{1}{2}$	$\frac{37}{64}$	$\frac{1}{4}$
$\frac{5}{16}$	$\frac{19}{32}$	$\frac{11}{16}$	$\frac{5}{16}$
$\frac{3}{8}$	$\frac{11}{16}$	$\frac{51}{64}$	$\frac{3}{8}$
$\frac{7}{16}$	$\frac{25}{32}$	$\frac{9}{16}$	$\frac{7}{16}$
$\frac{1}{2}$	$\frac{7}{8}$	1	$\frac{1}{2}$
$\frac{9}{16}$	$\frac{31}{32}$	$1\frac{1}{8}$	$\frac{9}{16}$
$\frac{5}{8}$	$1\frac{1}{16}$	$1\frac{7}{32}$	$\frac{5}{8}$
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{7}{16}$	$\frac{3}{4}$
$\frac{7}{8}$	$1\frac{7}{16}$	$1\frac{21}{32}$	$\frac{7}{8}$
1	$1\frac{5}{8}$	$1\frac{7}{8}$	1
$1\frac{1}{8}$	$1\frac{13}{16}$	$2\frac{3}{32}$	$1\frac{1}{8}$
$1\frac{1}{4}$	2	$2\frac{5}{16}$	$1\frac{1}{4}$
$1\frac{3}{8}$	$2\frac{3}{16}$	$2\frac{17}{32}$	$1\frac{3}{8}$
$1\frac{1}{2}$	$2\frac{3}{8}$	$2\frac{3}{4}$	$1\frac{1}{2}$
$1\frac{5}{8}$	$2\frac{9}{16}$	$2\frac{31}{32}$	$1\frac{5}{8}$
$1\frac{3}{4}$	$2\frac{3}{4}$	$3\frac{3}{16}$	$1\frac{3}{4}$
$1\frac{7}{8}$	$2\frac{15}{16}$	$3\frac{13}{32}$	$1\frac{7}{8}$
2	$3\frac{1}{8}$	$3\frac{5}{8}$	2

A revolution is being worked in woodcarving. For years it has been the dream of inventors and woodworkers to devise a machine which would do for furniture makers what the labor-saving machinery has achieved in the manufacture of shoes. A certain amount of preliminary carving has been done for several years. The rough carving of the ornamental woodwork of sleeping-cars is done by machinery, but has to be guided by a skilled man and finished by hand. The *Furniture Journal* for April 10 contains a full description of a machine built by S. Waupen & Bros. of Chicago. This machine when once started carves eight pieces at one time without any attention from the operator until the operation is finished.

A Jamestown, N. Y., dispatch states that Capt. F. P. Cobham of that place has invented a system of wireless signaling between railway trains which, it is stated, has worked satisfactorily in tests. The instruments, which are placed on the locomotive, give notice when the engine is within two thousand feet of another engine on the same track, and at the same time indicate in which direction each locomotive is moving. If one of the locomotives is stationary the fact is also indicated.

PHOTOGRAPHY.

ORTHOCHROMATIC PLATES.

To THE beginner in photographic work the use of other than an ordinary plate seems surrounded with difficulties which deter many from making trials that would be exceedingly profitable as well as interesting, and lead to more satisfactory results in the print. Many who have acquired the ability to make, and do make, good exposures, have been disappointed with the prints, which fail to correctly represent the view. The sky in a landscape is too white, and clouds are barely discernible which, in the original view, were strongly outlined. The tints and colors of a building are not correctly represented in the shadings of the print. And so we are disappointed with our work and, too many times, come to look upon photography as a subject beyond reach of those who would engage in it as a pleasure and means of developing the artistic side of our nature.

And why is this? The answer is simple. Because we have neglected to use the proper materials for securing the results we are seeking. A few words of explanation regarding the action of the light rays upon the plate will make this clearer. All of us have some knowledge of the spectrum; that sunlight is composed of a combination of seven primary colors. The rainbow is but a division into the original colors of the light of the sun. The eye receives a correct impression of the hues and colors in view. Not so with the photographic plate, which is subject to chemical action when exposed to light. In the ordinary plate this action is not in true accord with the colors in the view, for the reason that some colors do not produce action which is quick enough, while others work too quickly to be in correct proportion to the view as an entirety.

The blue of the sky and the white in clouds are of about equal rapidity in their action upon the ordinary plate, thus producing a bare and unbroken sky effect in the resulting print. Red, orange and yellow, on the other hand, reflect much less light, and so do not sufficiently affect the plate, and consequently appear much darker in the print than to the eye. It is these variations from a true representation of the view that cause so much disappointment to the beginner and yet is a condition which is easily remedied by using orthochromatic plates. This does not mean that such plates should be used at any and all times, but there are many occasions when such plates will enable one to secure effects which would be entirely lacking should an ordinary plate be used. A few trials will plainly show the difference in the two kinds of plates. An instructive experiment is to take exposures of the same view on the two kinds and study the difference in the prints made therefrom. The difference between an orthochromatic and an ordinary plate is, that the former is specially sensitized to the red and yellow rays, which act more quickly on these plates and so are more nearly reproduced in their correct values.

A necessary adjunct to orthochromatic plates is a ray screen, though it is not always used when making exposures with such plates. A little study of the conditions of light at the time of exposure will determine the advisability of using it or not. The ray screen serves the purpose of reducing the intensity of action of the blue and violet rays, and fittingly supplements the use of plates that will correctly reproduce the red and yellow values. At certain times of the day, as at sunset, the blue sky is subdued by the brilliant orange or red tones of the setting sun, thus dispensing with the necessity of the screen.

In using an orthochromatic plate without a screen, the time of exposure is about the same as with an ordinary plate of the same sensitiveness. With the screen, the exposure should be increased from four to eight times, according to the degree of light. A few trials will enable one to ascertain the correct time. In one important particular orthochromatic plates differ somewhat from ordinary plates. Being very sensitive to red and yellow light, they should be loaded into holders in very dim light, which should be so shielded as not to shine directly on the plates, and the supply box should also be kept well protected. Also, in developing the same care should be used until the developer has been applied, when a little more light may safely be used. The greatest care should

be used, however, in all handling until developing is well under way. The developer used should be that recommended by the manufacturer of the plates, if obtainable, and is used the same way as with an ordinary plate.

The cost of these plates is slightly more than for the ordinary kind, but the difference is not great enough to be a serious consideration, in view of the results to be secured by their use. If kept in a dry, cool place, they will keep well, though fresh plates are desirable, whichever kind are used.

PINHOLES IN NEGATIVES.

The inexperienced amateur often finds in his negatives small pinholes, which cause dark spots to appear in the print. As careful workers are rarely troubled by them, the cause must be one which may be avoided by the exercise of proper care. We will here consider their causes and the remedies for them. The larger number are due to dust, which collects in the bellows and frame of the camera and in the plate-holders. This is especially true if the camera has not been used for some time. The camera should be gone over at suitable intervals with a damp, but not wet, cloth, and the plate-holders in the same way. This may easily be done when plates are taken out for development, but after the developing is finished. Before loading, the holders should always be dusted with a camel's-hair brush, and likewise the plates. When in a hurry one is very apt to neglect this, but will generally regret having done so.

Before developing, the plates should be brushed, and with plates that have been in the holder for some time before exposure, a gentle cleaning with wet absorbent cotton just before developing will help matters. The developer sometimes forms air bubbles, which may be prevented by blowing the developer so that it fully covers the plate with one sweep. In addition, a swab of absorbent cotton may be gently passed over the plate to insure all parts being thoroughly reached by the developer; but this should be done immediately after immersion in the developer.

If, after using due care, such spots are still found in the negative, they may, if not too numerous, be removed by "spotting." This consists in applying a suitable pigment, such as India ink or water-color, with a fine camel's-hair brush. The negative should be inclined on a framework, back of which has been placed a sheet of white paper, so that the lines of the negative will be quite distinct. The light should come from the back of the stand, with the worker facing it. A reading-glass may be used to good advantage in this work, as it enables the color to be applied with a greater nicety, which is very desirable.

The color used should match as closely as possible that of the film, so that the printing quality will be uniform. The color should be of considerable consistency, and very little taken into the brush at one time. If too moist, it will very likely make a bad matter worse. It should be applied very delicately and slowly, that the surrounding film may not be injured, and should be free from dust. Clean water should be used for mixing it. After applying a little color to a spot, work on another while the first is drying; returning to it later, if necessary. If too much is put on, let it dry and then remove with the point of a fine needle rather than with a wet brush. A little practice will enable one to greatly improve a negative, the printing qualities of which are injured by pinholes.

The Vancouver Power Company will soon undertake a novel piece of hydraulic engineering work in connection with an electric transmission project. A water-power electric generating station is located near the headwaters of the Coquitlam River, and to add to the supply of water furnished by a dam it is proposed to tap a lake at an altitude of 2,500 feet above the sea. Instead of laying a pipe line, the company will drive an inclined tunnel through a mountain of solid rock. The bore will be 3 feet by 8 feet, and 2½ miles in length. The cost of the tunnel is estimated at $350,000. The cities of Vancouver, B. C., and New Westminster will be supplied with current from this source.

Coal in China.— A coal-field of great extent, yielding fuel of a high quality, will shortly be in full operation within a few hours' steaming of Shanghai. The new fuel lies in the province of Anhui, near Ngankin, the capital, on the Yangtse.

A MODEL STEAMBOAT.

WM. M. FRANCIS.

WHEN I was a boy I made several small boats which were propelled by steam or clockworks, some using paddle wheels and others were propellers (screw). I have recently made one for my own boy and think it may interest some of the readers of this magazine to know how it was built. The first thing to obtain is a set of works from an old alarm clock. A cheap one of the kind sold in most every jewelry store will do. An old one can often be obtained of a jeweler who will give it away to get rid of it. Of course it must be in good enough order to run when wound, after removing the escapement. Other works would perhaps do, but would probably require a larger boat. The size of the works governs the construction to quite a degree. To prepare the works, remove all spindles and gears except the large one carrying the mainspring and two or three spindles which run in train with it. By referring to Fig. 4 it will be seen what is meant, and if the gear in the works does not come so that it will drive the propeller gear at the top, as shown, it may be driven from the underside.

For the hull obtain a clear straight-grained piece of white pine 3″ x 3¾″ x 1′ 3″ long. Lay out the curve for the lines or shear of the deck by driving in a brad at the edge of the top side at about the position of the center section in Fig. 1. Bend a thin piece of wood, taking it by both ends and bending it against the brad, while some one marks the curve on the block to be sawed.

Also mark the piece to be sawed out on the under part of the stern. Any one who has a band-saw will saw these out in a few minutes. Otherwise, cut away with a saw and chisel or draw-knife. Or a templet can be made of thin wood, and one side of the boat marked out. Then turn the templet over and mark the other side, as shown in plan, Fig. 2. If a center line has been drawn from end to end of the boat, and the templet applied to it, both sides of the boat will be of the same curve, which may now be sawed out on this curve. Next make templets for the different sections of the boat as shown in Fig. 3. These can be drawn on thick cardboard or thin wood and cut out with a knife. By applying the templets to each side as the work progresses they may be exactly alike, though much of the boat will have to be judged with the eye. With these templets for guides, cut out the lines of the boat with a chisel or gouge. During this work the block should be clamped to the bench, using thin pieces of wood to prevent the clamp from jamming the block. A set of carving tools will be very useful for this work.

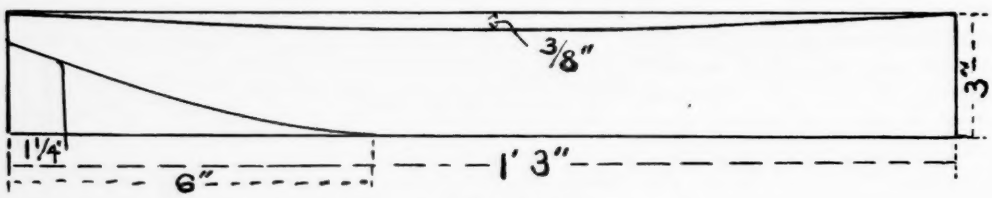


FIG. 1.

After finishing one side, additional templets can be made of curves at different points in the length of the hull and the other side finished to these templets. One who has a good eye can dispense with the templets and, in the absence of other tools, fashion the whole hull with nothing but a jackknife. All the curves of course gradually merge into one another so that the eye can scarcely perceive the change. The lines of a large boat or ship are laid out in exactly the same way, but there is a templet for every rib. If the person has never made a boat before, he had better

examine some boat that is drawn out of water or one that is being built.

The next step is to hollow the boat. Take a pencil and draw a line around the deck about $\frac{3}{8}''$ from the edge, following the outline of the hull. The line is shown in plan, Fig. 2. Take two pieces of board and cut them out like Fig. 6 to fit the bottom of the boat at points near the ends and nail them to the bench as shown. The boat may now be placed in them, right side up, and clamped, again using a piece of wood to keep from bruising the wood. Go around this line with a sharp knife or carver's V tool, taking care not to split the side anywhere. Remove what of the boat, but may be more toward the bow and stern. The depth should be about $\frac{1}{8}''$, or sufficient to receive the piece of thin board of which you make the deck. A piece of a long cigar box will answer nicely and makes a nice appearance when finished.

A piece of pine about $\frac{1}{2}''$ square section is now to be inserted across the hull to carry the end of the propeller shaft. This piece has to be let down flush with the top of the ledge so that the deck will lay down on it. Also insert another piece a little forward of the works to help hold up the forward part of the deck. These pieces should be fastened by small nails or screws, as shown in

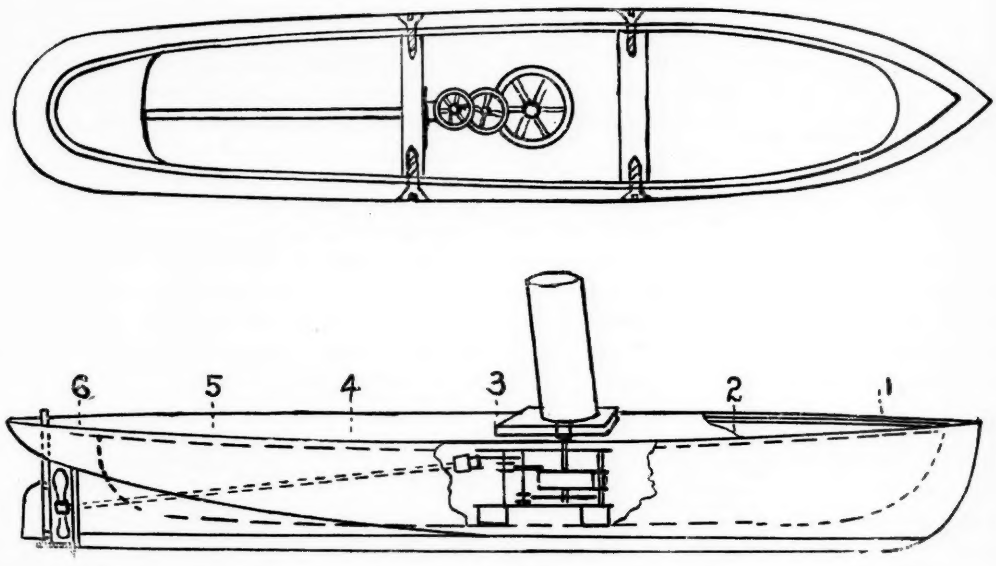


Fig. 2.

wood can safely be done with a bit, and then take a gouge or narrow chisel and hollow out the boat about to dotted lines shown in elevation, Fig. 2. Great care must now be used that a hole is not cut through the side, and the work must be carefully gauged to have about an equal thickness at all similar points of the sides. The clockworks must be fitted at a point about midships, and more wood may have to be taken out in places to accommodate them. After the inside of the hull is done, a ledge must be cut, on which to lay the deck. This should be about $\frac{3}{16}''$ wide at the sides Fig. 2. The deck may now be fitted, using care in springing it down when trying it. It is to be fastened with small, countersunk screws to the ledge and the pieces across the hull, taking care to put no screws where the propeller shaft is to be. We now want a piece of brass $\frac{1}{16}''$ x $5\frac{1}{16}''$ x $3''$ long for stern shoe, another piece $\frac{1}{23}''$ x $\frac{3}{8}''$ x $2''$ long for blades of the propeller, and a piece about $\frac{1}{32}''$ x $\frac{1}{2}''$ x $1''$ long to go on the crosspiece for propeller gear to run against. These may be cut from the metal case of the clock if not otherwise obtainable. Also a piece of straight steel wire about

$\frac{3}{32}''$ in diameter, 8″ or 9″ long, for shaft. Also a piece of brass tube about the same length, in which the wire shaft will fit quite loosely. These articles may all be obtained at any large hardware store and would probably not cost over 15 cents. Also get a piece of lead $\frac{1}{16}'' \times 1'' \times 15''$ for a lead keel, which is doubled in the middle lengthwise and hammered together on a smooth piece of iron or an anvil so as to make a keel $\frac{1}{2}''$ wide and $\frac{1}{8}''$ thick.

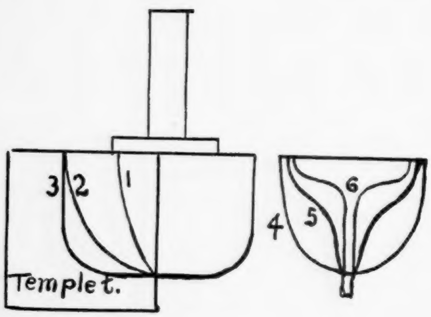


Fig. 3.

Open it a little at five or six points in the length, and with an awl or small drill put some holes through so that the keel may be bradded to the hull, but do not put the keel on until the boat is completed (see Fig. 2).

was inserted across the hull. Also bore a hole through this piece to the same angle. This is shown in elevation, Fig. 2. The piece of tube is to fit in this hole and must not be sprung to put it in, but rather than spring it, the hole may be a loose fit and any leaks around the tube afterwards stopped with putty or thick lead paint. The reason the shaft is put in at this angle is to bring the inside end always above water, so that none will leak into the boat. If it had been put in level with the keel, it would have to be packed to keep out the water, making a lot of needless friction. Next take the piece of brass $\frac{1}{16}''$ thick, and make the stern shoe, as shown in Fig. 4 and in Fig. 2. The hole in this is not to fit the shaft, but the tube, which should be left projecting astern $\frac{1}{16}''$ for the hub of the screw to run against. The shoe, besides having holes in it for the tube and rudder post, is to have two or three screw or brad holes in it to fasten it on to the hull. The tube is also to be soldered to it.

Now take the piece of brass 1″ long and drill a hole in the center for the shaft, which should revolve freely but without any rattle. Also drill two screw holes in it for screws, and fasten it to the crosspiece. The crosspiece will have to be beveled a little on the stern side, so as to bring the brass piece at right angles with the shaft. Put in the tube far enough to butt against the brass

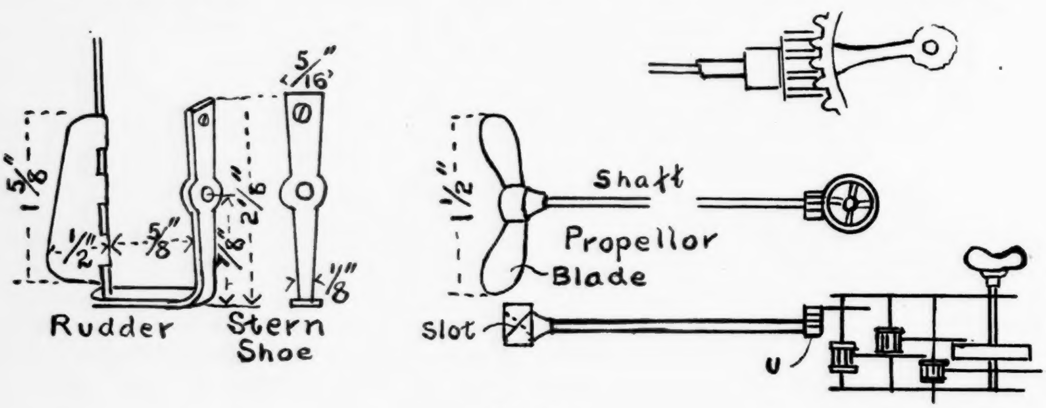
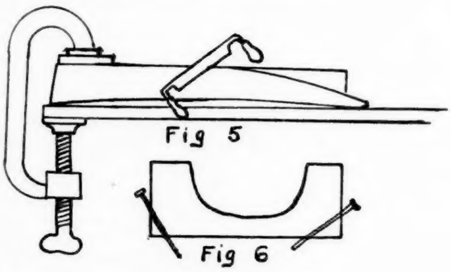


Fig. 4.

With a small drill or gimlet bore a hole about $\frac{1}{2}''$ from the bottom of the boat and in the center of the sternpost, at an upward angle so as to line with the center of the after piece of wood that

piece and cut off to the right length by going around it with a three-cornered file. Now putty and wedge the outside end of the tube, if necessary, to prevent leaks; also fasten on the shoe

for the rudder and solder the tube to it. To make the propeller, take one of the keys of the clock that was used to wind up the alarm, remove the flat part that is hinged in it. In the hub, saw two slats with a backsaw on opposite sides at an angle of nearly 45 degrees with the shaft and about $\frac{1}{16}''$ deep. It is necessary to determine from the direction in which the works or last gear meshes with the propeller gear, which way the shaft will turn, as the cutting edge of the propeller should be nearest the stern. If the shaft will turn in the direction of the arrow near the hub shown in Fig. 4, the slots will have to be cut as there shown. If not, the slots will have to be cut as shown by the dotted lines. Cut out the two blades of about the shape shown in sketch and solder them in the slots in the hub. Take the tip of each blade in the jaws of a pair of plyers or vise and twist the blades so that they will not have quite as much angle as the sawcuts, say 30 degrees.



Now insert the propeller shaft in the hole in the hub and solder it in. It is better to separately tin the hole and the end of shaft, and then hold both over a spirit or naphtha torch and when hot shove the two together. Put the shaft in the stern tube and cut to the right length. One of the gears of the hand movement of the clock can be used for the propeller gear. By pointing the teeth of the small gear a little with a thin file, it will run very nicely when meshed with the driving gear of the works as shown. When the shaft is in place, solder the propeller gear to the inside end in the same way the hub was soldered.

Two pieces must be now fitted in the inner bottom of the boat and trimmed so as to bring the works to exactly the right height that the gears may properly mesh. They should not bind, but revolve quite freely. When fitted, screw the pieces to the bottom and then screw the works to these pieces. This must be done firmly, to prevent any jar or dropping of the boat from bringing the gears out of mesh. Wind up the spring and see if the works run freely. In the deck piece cut an oblong hole through which to oil and inspect the works. Around the hole put some pieces of wood about $\frac{1}{8}''$ x $\frac{3}{8}''$ for a combing. For a cover, I used an oblong stamped cover of a mustard box with rounded corners, making the hatch of the size to fit. This should fit snugly, so that it will not drop off if the boat is turned over. To this cover, solder a piece of thin brass tube or tin speaking-tube to represent a smokestack. Bevel the ends a little so that the stack will lean aft a little. The hatch, of course, has to be so placed that the key to wind the works can be reached. Fasten on the lead keel, and the boat is ready for trial in the water. If it does not trim just right (owing to the works being set to one side to work the gears), a small lead weight may be screwed inside the boat so as to make it trim right. Wind up and try the boat in the water before putting on the deck. If it runs all right, give the joint of the deck ledge a thin coat of putty or white lead and screw it permanently in place. Putty all cracks around the joint of the deck and combing of hatch, and after the boat is thoroughly dry, paint to suit the taste. The rudder is made of a piece of tin cut and bent as shown in sketch, and soldered to a piece of the wire used for the propeller shaft. A hole is bored in the hull at the stern so that the wire fits tight enough to keep the rudder in any position in which it is placed. Owing to the bottom half of the propeller having a more solid body of water to work on than the top half, the boat will have a tendency to turn in a circle. The rudder should be placed to steer against this, and the boat will then run straight. The boat here described will run a quarter of an hour at one winding, is quite speedy, and will tow quite a large boat or plank. It should be run in water clear of weeds, as if anything gets around the propeller it may take considerable trouble to get the boat.

There is some talk of operating all the principal railways in Switzerland by electricity instead of steam. It is thought that the power which could be derived from Swiss waterfalls would be sufficient to provide enough electrical energy for the entire railway system of the country.

AN EASILY MADE ICE-CHEST.

M. H. Warren.

The ice-chest here described was made for a summer camp. Ice had to be carried three miles in a boat, and without ice the provisions spoiled. A box sunk in the ground had previously been used, but as it was wasteful of ice and not very handy, something better was needed. This chest proved to be quite as efficient as a purchased one, costing but little, and quite easy to make. Here is a description of how I made it:

The materials used were two shoe cases and a packing case, a sheet of zinc 24″ x 36″, hinges, handles, screws and nails. The lining was chopped

cork used for shipping Malaga grapes, a kegful being purchased of a fruit dealer for ten cents. If it cannot be obtained, sawdust may be used, but it is not quite as good. The edges of the boards should be matched, to make joints as tight as possible and well driven together before nailing. The shoe cases were carefully taken apart and used to make the outside of the chest.

The packing case, used for the inside walls, was in such good condition that no changes were made in it, thus saving some work. It measured, inside, 25½″ long, 14½″ wide and 18″ deep, but any other size may be used. Around the bottom, sides and ends were nailed strips of wood 2″ wide and 1″ thick to form a space for the cork lining. The pieces for three edges were put on first, the bottom boards then nailed on; the cork put in and the fourth strip then put on, nailing it through the bottom board. The cork should be firmly rammed down with a stick, so that it cannot settle and leave a vacant space. The bottom being finished, the ends and then the sides are made in the same way. The illustration clearly shows the construction. The top pieces forming the cork spaces are not nailed until the cork has been packed. The side pieces of the outside sheathing lap the ends, and should not be sawed until the correct length can be ascertained, after making the ends. The top of the chest was finished by strips mitered at the corners as shown, giving the chest a finished appearance.

The cover was made of well-matched pieces from one of the shoe cases, the top layer running lengthwise, and a lower layer, which loosely fitted the top of the chest, running crosswise. By taking measurements and marking the underside of the top pieces, the location of the lower layer can be determined without difficulty, and then the two parts are well nailed together with short nails. Around the front of the cover and the two ends, a strip 1½″ wide and ½″ thick was nailed, thus preventing any chance for air to circulate around the joints between cover and chest. The top layer of cover should be a trifle larger than the chest, so that these strips will not bind anywhere. The two hinges at the back are well sunk into the wood to make a tight joint when closed.

The legs were pieces of wood 2″ square and 6″ long. Around the outsides of the tops were nailed short pieces of board which were nailed to the bottom of the chest. A piece of zinc 24″ x 36″ was used for lining the bottom and about 5″ up on the sides and ends. The inside of the chest was carefully measured, and the dimensions marked on the center of the piece of zinc, the lines being extended to each edge. The corners were then cut off with metal shears, the pieces cut off being saved to be used as will be mentioned. The sides were then bent up, so that a shallow box was formed, considerable careful hammering being needed to get square edges. The corner joints were then carefully soldered. A plumber would probably make the box lining for a small sum if any one did not care to do this part of the work. The drip-pipe was made of one of the corner

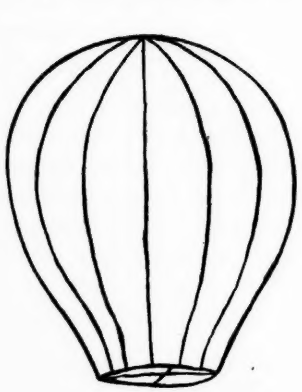
pieces cut from the sheet of zinc. It was bent around a piece of broom-handle and then cut so that the edges just met, the edges being trued up with a file. It was then fastened to the broom-handle with tacks at each end, so that the joint would be held firm when soldering. This formed a piece of zinc pipe about 5″ long and 1″ in diameter. A slight flange is made to one end with pincers, so that it may be soldered to the lining.

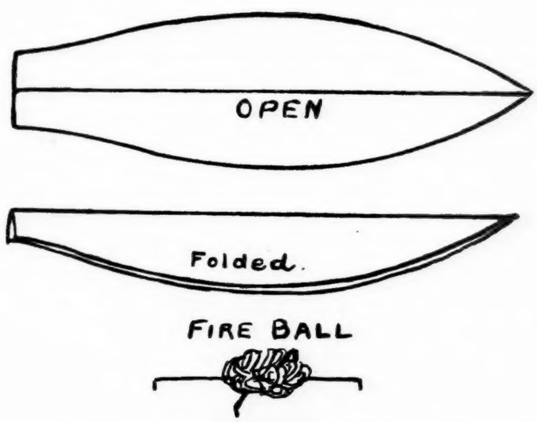
A 1″ hole was bored in one corner of the bottom of the chest. The bit was put through until the screw-point projected through the bottom, then withdrawn, the zinc tube inserted, and the hole finished by boring from the underside, the zinc tube being pushed through as the bit was withdrawn. This prevents the cork lining from falling out. The lining was then put in, a hole having been previously made where the drip-pipe comes. The top edge of the lining was fastened by tinned tacks. A strip of wood 1″ wide and $\frac{1}{2}$″ thick was then nailed along each side, about half-way between top and bottom, for holding shelves, which were made of $\frac{1}{2}$″ boards. A wooden frame of 1″ oak was made for the bottom, so that when putting in the ice the zinc would not be dented or broken. The inside woodwork was then given two coats of shellac, cut with alcohol. Paint should not be used, as the turpentine and oil in it are objectionable for this purpose. The outside was stained a dark brown, after puttying up the cracks, and shellacked.

HOT-AIR BALLOONS.

M. I. Jones.

For several years I have concluded my 4th of July celebration by sending up several hot-air balloons, and as my companions have found the event one of much enjoyment, I presume many of the readers of Amateur Work would be interested to know about them. The balloons were homemade and inexpensive, the latter item being one that will appeal strongly to boys who always have so many uses for money on our national holiday.





I usually make two sizes, the smaller ones of tissue paper, and the larger ones of white newspaper, which I get from a newspaper office where large rolls are used on what is called a web-press. These rolls are taken from the press before all the paper is used, from five to twenty yards remaining on the roll. Enough of this paper can be obtained for a small sum to make several large balloons. Such paper can be obtained from any newspaper office where web-presses are used. If this paper

cannot be secured, thin manilla wrapping paper will answer.

A cigar-shaped pattern should first be made of thick manilla paper. For a balloon 6′ high, the pattern should be 9′ long, 18″ wide in the middle and 5″ wide at the bottom, coming to a point at the top. To make the pattern, paste enough paper to form a rectangular piece of above outside dimensions. Fold lengthwise in the center, and draw with a pencil the curved line of one side. A long strip of wood may be bent so as to secure an even curve and held in place by nails while the pattern is marked. The natural curvature of the wood will give the correct shape. The pattern as marked is then cut out, using care to cut both layers of paper alike.

For a balloon 4′ high the pattern should be 6′ 3″ long, 12″ wide in the center and 4″ at the bottom. Thirteen stripes are made for either size, the dimensions given allowing a $\frac{7}{8}$″ lap for seams on the larger size and $\frac{1}{2}$″ lap on the smaller one. Examine each strip after cutting, for holes, and if any are found, pieces of paper should be pasted over them. Use a good grade of photography paste for joining the seams. Mucilage dries too hard and is apt to crack in handling when dry. A quick and convenient way to paste up the seams is on a wooden mold. One end of a piece of 2 x 3″ joist 8′ long was clamped to the workbench. A flexible piece of wood was bent to conform to the shape of the paper strips, being held in place by nailing to it, and the joist strips of wood placed about 18″ apart.

The edge of one piece of paper is then covered with paste and placed on the form, and the edge of another piece laid over it, beginning at the center and working towards each end. The strips were joined in pairs, then the pairs were joined, and so on, this giving time for a seam to dry before again working on the same piece. At the top a loop of small but strong twine was attached with a darning needle. This loop is used to support the balloon when inflating. For the bottom of the balloon, make a loop of old telephone wire or a piece of cheese box of the size of the opening; in the larger size about 18″ and the smaller size 15″ in diameter. Two strong cross-wires are connected to the loop, forming an X-shaped support for the fire-ball. The hoop is then attached by lapping over the bottom of the paper strips and pasting.

The fire-ball is made of cotton twine, which must be untwisted so as to be loose and soft. It is loosely coiled into a flattened ball about 4″ in diameter and attached to the top of an X-shaped wire frame, the ends of which are bent down so as to twist around the crosspieces to the hoop of the balloon, when ready to light.

Supposing the eventful evening to have arrived, we would send up the balloon in the following manner: In an old tomato-can put some shavings well covered with kerosene. On two bricks or stones support a short length of stovepipe, in the bottom of which is placed the tomato-can. Light the kerosene, and as soon as it has stopped smoking and the hot air is coming up the pipe, hold the balloon over the pipe and it will quickly become filled with hot air. The top of the balloon is supported with a long stick with a wire hook on the end, which holds the string loop in the top of the balloon. As soon as the hot air has well filled the balloon, it will tug strongly to rise, and should be removed from the stovepipe. The fire-ball is now saturated with kerosene, quickly placed on the top of the crosspieces of the hoop and fastened in place. It is lighted, and as soon as it is blazing well, the balloon should have enough lifting power to rise well. If this be the case, it may be released and will undoubtedly soar rapidly aloft and away in the direction the wind is blowing.

An open field should be selected for sending up the balloon, and care should be taken to see that it has plenty of lifting power before being released. If much wind is blowing, a sheltered place will be necessary, otherwise the balloon is very likely to heel over so far as to become ignited and the labor and pleasure lost.

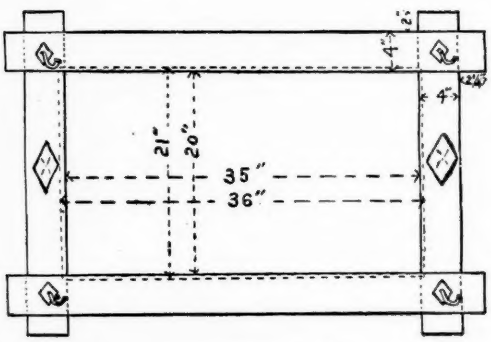
Referring to the recent enactment of the New York Board of Health, to prevent contagion from the promiscuous use of brushes, scissors, razors, etc., in barbers' shops, *The Lancet* (London, April 5) says: "The question arises whether the barbers will endeavor to meet these new exigencies. Historically speaking, the barbers, whose precursors used to be barber-surgeons, should readily appreciate the advantage of antiseptic surgery, and be willing to apply its principles to the minor and painless operations which they now perform.

OLD DUTCH FURNITURE.

John F. Adams.

VI. Hall Mirror.

The hall mirror here described is designed as a companion piece to the settle given in the March number of this magazine. The frame should be made of selected quartered oak $\frac{7}{8}''$ thick and 4″ wide. Two pieces 48″ long and two pieces 32″ long are required. The joints are made by halving, care being taken to make them a snug fit and perfectly square. The rabbet or recess on the inside edges for the mirror may easily be made with a backsaw. They are $\frac{1}{2}''$ wide and $\frac{3}{8}''$ deep. Mark the line to be sawed; bore a hole at each end with a $\frac{1}{4}''$ bit. Then lightly nail a thin $\frac{1}{2}''$



square strip of wood on each side of the line, having just room enough between them for inserting the blade of the saw. Before beginning to saw, mark on the saw blade, with a pencil, a line showing where the saw will be when the right depth of cut has been made. When one cut has been made, take off the strip and repeat the process for the other cut. Smooth up any rough places with a sharp chisel or rabbet plane, and see that the depth is uniform, so that the mirror will rest evenly at all parts. The ends of the long pieces extend on the sides $2\frac{1}{4}''$, and the side pieces extend 2″ at top and bottom, as shown in the illustration.

Fasten the joints together with glue and by $\frac{3}{4}''$ screws from the back, countersinking the heads. Bore holes for the screws, using care not to bore through to the front of the frame. Put the screws in the corners of the joints, so as to leave a clear space for attaching the hat-hooks or other ornaments. A mirror of this size is quite heavy, necessitating a strong frame to securely hold it. The size is 36″ long and 21″ wide. If desired, the upright pieces may be made 3″ longer, allowing 3″ greater width for the mirror. The backing is made of thick picture-frame backing or any wood $\frac{1}{8}''$ thick, and should be securely nailed in. A piece of thick manilla paper is put between the mirror and the backing, to prevent scratching the former.

The hat-hooks are put one in each corner, and may be of brass or black iron, the latter being most in harmony with the design, though probably difficult to obtain in many places. In the center of the side pieces candle brackets may be added and escutcheon ornaments in other places, as may suit the fancy. Two brass pieces, with screw holes for attaching to the wall, are firmly screwed to the back of the top piece and one to the bottom piece, so that the weight of coats will not cause it to fall. The frame is finished with stain to match the settle. If the work is well done, a substantial and quite ornamental piece of furniture will result.

An electrical fly-trap has been patented by an inventive genius residing in Providence, R. I., Mr. Edwin R. Greene, by name. A frame is employed which is constructed of insulating material, and comprises a central longitudinal plate and top and bottom bars, the whole being connected by intermediate strips. Around this frame are wound sets of positive and negative wires spaced a slight distance apart to form a grid, the spaces between the wires being such that should a fly alight on the grid it will necessarily touch two wires. Bait is placed upon the center plate within the grid, and the arrangement is connected up with an electric current. A horizontal platform is suspended beneath the trap to catch the flies that may be electrocuted. The operation of the device will be apparent. The insects attracted by the bait within the grid will alight upon the wires and be electrocuted, whereupon they will drop down upon the horizontal platform, this platform being so arranged that it may be cleaned as often as desired.

How to Color Electric Lamps.— Very often much effectiveness can be worked out in a window trim with the aid of colored lights, says the *Dry Goods Reporter.* Colored lights are expensive. The following formula will explain how to color electric lamps, thereby saving a big part of the expense. Take a little white shellac, thin it down with alcohol, and by dipping the bulb in this it produces a splendid imitation of frosted glass when a clear white light is required. Care must be taken to have the shellac very thin, otherwise it will not run smooth. If you use green, purple, red, blue or any other color, buy a package of egg dye of the color required, dissolve it in wood alcohol and pour it into the shellac. By using this or any transparent coloring a vast number of beautiful tints can be made that will blend with your color scheme.

To go about it properly and to get the best results, after preparing your shellac pour it in a vessel deep enough to immerse the lamp. Take a piece of wire and fasten it around the socket of the lamp, then bring one end of wire back over the end of the lamp to opposite side of lamp to form a loop, then dip it in the solution and hang it up to drip and dry. While mixing your color bear in mind that the more dye and the less shellac the deeper the tint will be, and *vice versa.* Any of these colors can be removed with wood alcohol.

M. Edward Brauly, the well-known French electrician, who has lately been interested in the problem of wireless telegraphy, says *The Scientific American*, has perfected a device which will considerably develop communication by this means. It is called the improved Brauly radio-conductor. The Brauly coherer is already employed in wireless telegraphy, but the value of the new device is the discovery that any two pieces of metal, provided one of them be polished or oxidized, will serve all purposes of the tube. Any metal will suffice for this object. The result has even been secured with a common needle. The new radio-conductor consists of a horizontal plaque of polished steel connected with one pole of the circuit, on which rests a small metallic tripod connected with the other pole, the three points of the tripod being oxidized.